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## (54) IMPROVEMENTS IN AND RELATING TO ROTARY PISTON MACHINES

(71) We, CHESHIRE SOFTWARE LIMITED, a British Company, of 10 James Street, Liverpool L2 7PQ, Lancashire, do hereby declare the invention for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The present invention relates to rotary piston machines.

A rotary piston machine in accordance with the present invention comprises a stator having a cylindrical inner surface, a cylindrical main rotor journalled coaxially within the stator so that an annular chamber is defined therebetween, at least one wall or so-called spur having two opposite sides which define a pointed apex extending radially inwardly relative to said cylindrical surface of the stator towards the main rotor, at least one pair of fluid inlet and outlet ports communicating with said annular chamber, the main rotor carrying at least one cylindrical planetary rotor which is located in a respective recess in the cylindrical surface of the main rotor for rotation about an axis parallel to the rotational axis of the main rotor, the or each planetary rotor having at least one recess extending longitudinally of that rotor, at leaest a portion of each recess being of concave, continuously curved, transverse profile and means for rotating the main and planetary rotors in opposite directions at respective speeds bearing a fixed ratio to one another such that when a planetary rotor passes a spur, the apex of that spur closely follows the continuously curved portion of that recess with the distance between the apex of that spur and the surface of the continuously curved portion of that rotor remaining substantially constant during the whole of the pass.

The invention will be described further, by way of example, with reference to the accompanying drawings, in which:

Fig. 1 is a sectional front elevation of one embodiment of a rotary pump or fluid motor in accordance with the present invention taken along the line I—I of Fig. 2;

Fig. 2 is a sectional end elevation through the pump or fluid motor of Fig. 1 along the line II—II;

Fig. 3 is a sectional front elevation of one embodiment of an internal combustion engine in accordance with the present invention taken along the line III—III of Fig. 4, and

Fig. 4 is a sectional end elevation through the engine of Fig. 3 along the line IV—IV.

The pump or fluid motor of Figs. 1 and 2 comprises a main rotor 110 which is mounted for rotation about a central axis 112 within a coaxial stator 114. The stator 114 has a cylindrical inner surface 116 which is radially spaced from a cylindrical outer surface 118 of the rotor 110 so that an annular space 120 is defined therebetween. End walls 121 are provided at the axial ends of the annular space 120 such that the space 120 is substantially wholly enclosed.

Located at diametrically opposite positions on the stator 114 are a pair of ports 122, 124 which are each divided into an inlet port 122*a*, 124*a* and an outlet port 122*b*, 124*a* by means of a pair of walls, or so-called spurs, 126, 128 extending radially inwardly towards the surface 118 of the main rotor 110 and acting as baffles. The spurs 126, 128 thereby divide the annular chamber 120 into two equal portions 120*a*, 120*b*.

The main rotor 110 carries three equally spaced apart, generally cylindrical planetary rotors 130*a*, 130*b*, 130*c* which are journalled for rotation about respective axes parallel to the axis 112 of the main rotor 110, such that a part of each planetary rotor projects radially outwardly from the peripheral surface 118 of the main rotor substantially to the inner surface 116 of the stator 114. The planetary rotors are located in respective recesses 131*a*, 131*b* and 131*c* in the main rotor and are coupled to the main rotor such that they rotate at a speed which is of opposite direction but of proportionate magnitude to the speed of the main rotor 110. The cylindrical periphery of each planetary

[*Price 25p*]

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rotor is provided with a respective recess 132*a*, 132*b*, 132*c* of concave, part-circular cross-section.

In order for the pump or fluid motor to operate efficiently, it is clearly desirable for the planetary rotors to be able to pass the spurs without transferring fluid from one side of the spur to the other. In order to achieve this action, the present embodiment is constructed such that, when a planetary rotor passes a spur 126, 128, the spur is accommodated in the recess in that planetary rotor with the apex 126*a*, 128*a* of the spur closely following the curve of the wall of that recess with the distance between the apex of that spur and the surface of the recess wall remaining substantially constant during the whole of the pass. It will be further observed that this latter action cannot be achieved if the peripheries of the planetary rotors are dimensioned such that they could effect a purely rolling motion relative to the inner surface 116 of the stator 114, i.e. a motion in which a point on the periphery of a planetary rotor travels a distance equal to the circumference of the inner surface of the stator when the main rotor effects a single revolution, since in these circumstances the apex of the spur would only lie closely adjacent to the wall of the recess in a planetary rotor at the apex of that recess. At other times during the passage of the planetary rotor past the spur, the spacing between the apex of the spur and the surface of the recess wall would vary so that an effective fluid tight joint between the two sides of the spur would not be achieved.

In the presently described embodiment constructed in accordance with the invention, the relative diameters of the planetary rotors and the internal surface 116 of the stator 114 are chosen such that the planetary rotors rotate at an angular velocity which is slower than that which they would have to effect to perform a rolling motion on to the inner surface 116 of the stator 114. In this case, there is therefore "slip" between the planetary rotors and the stator surface 116, the provision of slip permitting the shapes of the spurs and planetary rotor recesses which achieve the operating performance provided by a machine in accordance with the present invention.

Thus in operation as a pump, when the main rotor 110 is rotated, fluid is drawn in through both input ports 122*a*, 124*a*, by virtue of the suction effect produced by the planetary rotors moving away from the inlet ports, and discharged through the outlet ports 124*b*, 122*b*, respectively. Fluid is thus carried between the pairs of inlet and outlet ports 122*a*, 124*b* and 124*a*, 122*b*. The pair of inlet ports 122*a*, 124*a* are normally connected in parallel by additional chambers or piping, as are the pair of outlet ports 122*b*, 124*b*, so that the two sides of the pump defined by the chamber portions 120*a*, 120*b* effectively operate in parallel.

The converse operation as a fluid motor is achieved by pumping fluid into the inlet ports whereby rotation of the main and planetary rotors is achieved.

When acting as a pump or as a fluid motor, the direction of operation is unimportant so that it is fully reversible, the inlet ports being capable of acting as outlet ports and vice versa.

Figs. 3 and 4 illustrate an embodiment of a rotary engine in accordance with the invention, the engine comprising a main rotor 210 which is mounted for rotation about a central axis 212 within a coaxial stator 214. The stator 214 has a cylindrical inner surface 216 which is radially spaced from a cylindrical outer surface 218 of the rotor 210 so that an annular space 220 is defined therebetween. End walls 221 are provided at the axial ends of the annular space 220 such that the space 220 is substantially wholly enclosed.

Located at diametrically opposite positions on the stator 214 are two spurs 222, 224 having a transverse profile of generally triangular configuration and which extend radially inwardly almost to the surface 218 of the main rotor 210 so as to effectively divide the annular chamber 220 into two equal portions 220*a*, 220*b* respectivelcy. The spur 224 has an apex 224*a* and leading and trailing, concave, continuously curved side surfaces 224*b* and 224*c* respectively and the spur 222 has an apex 222*a* and leading and trailing, concave, continuously curved side surfaces 222*b* and 222*c* respectively. The stator 214 has an inlet bore 226 and an outlet bore 228 extending therethrough, the inlet bore 226 communicating with the chamber portion 220*a* *via* an inlet port 230 in the concave trailing side surface 222*c* of the spur 222 and the outlet bore 228 communicating with the chamber portion 220*b* *via* an outlet portion 232 in the concave leading side surface 222*b* of the spur 222.

The main rotor 210 carries two diametrically oppositely located, cylindrical planetary rotors 240, 242 which are journalled for rotation about respective axes parallel to the axis 212 of the main rotor 210, such that a part of each planetary rotor projects radially outwardly from the peripheral surface 218 of the main rotor substantially to the inner surface 216 of the stator 214. The planetary rotors 240, 242 are located in respective recesses 244*a*, 244*b* in the main rotor and are coupled to the main rotor such that they rotate at a speed which is of opposite direction but of proportionate magnitude to the speed of the main rotor 210.

The cylindrical periphery of each planetary rotor is provided with a respective recess

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having at the axial ends thereof portions 246*a* with walls that are continuously curved in profile but with a central deeper portion 246*b* having a wall with a more straight sided configuration in profile intermediate the portions 246*a*. The reason for the provision of the central portions 246*b* will become apparent from the following description of the operation of the above described engine.

In this embodiment, the direction of operation of the main rotor 210 is anti-clockwise and the planetary rotors 240, 242 clockwise. When a planetary rotor moves away from the inlet port 230, it draws a charge of air into the passage portion 220*a*. Just after this planetary rotor passes the spur 224, the second planetary rotor arrives at the position occupied by rotor 240 so that the inlet port is blocked relative to said charge of air. As the second planetary rotor moves towards the spur 224, the charge of air is compressed between this second rotor and the spur 224, the apex 224*a* of the spur 224 being in sufficiently good sealing contact with the peripheral surface 218 of the main rotor 210 to substantially prevent passage of air past the spur 224. However, it will be observed that when the planetary rotors pass the spur 224, there exists a clearance between the apex 224*a* of the spur and the base of the deeper recess portion 246*b* in the planetary rotor. This allows the compressed air to be transferred from one side of the spur 224 to the other, in this case from the left to the right hand side as viewed in Fig. 3. It will be noted however, that during the movement of the planetary rotor past the spur 224, the longitudinal edges 245*a*, 245*b* of the planetary rotor maintain sliding contact at all times with either the concave leading or trailing side surface of the spur 224. Furthermore, the apex of the spur 224 maintains sliding contact with the outer concave surface portions of the planetary rotor recess as that rotor passes the spur 224.

The second planetary rotor is eventually in the position occupied by the rotor 242 in Fig. 3, the compressed air charge having been transferred to the right-hand side of the spur and being contained between the recess of this planetary rotor and the trailing side surface 224*c* of the spur 224 which thereby define a combustion chamber at this instant. Fuel is then arranged to be injected via an injection port 250 and the mixture ignited by a spark plug 252, the resulting explosion urging the second planetary rotor, and hence the main rotor, in an anticlockwise direction and constituting the power stroke of the engine. The exhaust gas so formed is then carried around the chamber portion 220*b* by the second planetary rotor and eventually discharged via the outlet port 232. Due to the clearance between the apex 222*a* of the spur 222 and the central, deeper portion 246*b* of the recess in the planetary rotors, a certain amount of exhaust gas can pass the spur 222 when a planetary rotor moves past this spur. However, the amount of exhaust gas passing the spur and mixing with the next charge of air in the passage portion 220*a* can be regarded as being insignificant and does not substantially affect the operation of the engine.

As in the case of the pump/fluid motor, the shape of the spurs, especially the spur 224, and the shape of the planetary rotor recesses, which permit the air to be compressed and then to be transferred to a combustion chamber for a subsequent power stroke, are possible because of the slip between the planetary rotors and the stator surface 116 i.e. because the planetary rotors are rotating more slowly relative to the stator surface 116 than they would if they were performing a rolling motion on the stator surface 116.

Dotted lines 127*a*, 127*b* have been indicated in Fig. 1 across the inlet and outlet ports 122*a*, 122*b* respectively for the purpose of indicating the paths of movement of the longitudinal edges of the part circular concave planetary rotor recess as the planetary rotor recess passes the spur 126. It will be noted that these dotted lines correspond in shape to the cross-sectional configuration of the spur 224 of the engine of Figs. 3 and 4.

Many other embodiments of pump/fluid motors or engines are possible. For example, the planetary rotors can have more than one recess therein, three or more planetary rotors can be provided, and the inlet and outlet ports can be of other configurations and locations.

The inlet and outlet ports need not be located radially outwardly of the annular chamber 120, 220 but can be located in the side or end walls 121, 221 of said chambers 120, 220.

WHAT WE CLAIM IS:—

1. A rotary piston machine comprising a stator having a cylindrical inner surface, a cylindrical main rotor journalled coaxially within the stator so that an annular chamber is defined therebetween, at least one wall or so-called spur having two opposite sides which define a pointed apex extending radially inwardly relative to said cylindrical surface of the stator towards the main rotor, at least one pair of fluid inlet and outlet ports communicating with said annular chamber, the main rotor carrying at least one cylindrical planetary rotor which is located in a respective recess in the cylindrical surface of the main rotor for rotation about an axis parallel to the rotational axis of the main rotor, the or each planetary rotor having at least one recess extending

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longitudinally of that rotor, at least a portion of each recess being of concave, continuously curved, transverse profile, and means for rotating the main and planetary rotors in opposite directions at respective speeds bearing a fixed ratio to one another such that when a planetary rotor passes a spur, the apex of that spur closely follows the continuously curved portion of that recess with the distance between the apex of that spur and the surface of the continuously curved portion of that rotor recess remaining substantially constant during the whole of the pass.

2. A machine as claimed in Claim 1 which is adapted for use as a pump or fluid motor and wherein the recess in each planetary rotor is of concave, continuously curved transverse profile over the whole length of the recess whereby, when a planetary rotor passes a spur, fluid in said annular chamber is substantially prevented from passing from one side of that spur to the other by virtue of the continuous close proximity of the apex of that spur to the surface of the recess in that planetary rotor during the whole of the pass.

3. A machine as claimed in Claim 2 in which an inlet port and an outlet port are located adjacent either side respectively of the or each spur whereby fluid is expelled from the annular chamber through the adjacent outlet port as a planetary rotor approaches the or each spur and fluid enters the annular chamber through the adjacent inlet port as that planetary rotor moves away from that spur.

4. A machine as claimed in Claim 3 in which there are two spurs located diametrically opposite one another on the stator, the inlet ports and outlet port associated with these two spurs being respectively connected in parallel.

5. A machine as claimed in Claim 4 in which there are three planetary rotors arranged at equally spaced locations on the main rotor.

6. A machine as claimed in Claim 1 which is adapted for use as an internal combustion engine and which has at least two of said spurs, wherein the or each planetary rotor recess has a portion of concave, continuously curved, transverse profile at each axial end thereof, the recess portion intermediate said end portions being deeper than said end portions whereby, when a planetary rotor passes a first of said spurs, fluid in said annular chamber, which has been compressed between that planetary rotor and said first spur as the planetary rotor moves towards that spur is transferred from one side of that spur to the other via said intermediate recess portion.

7. A machine as claimed in Claim 6 in which said first spur has a transverse profile of generally triangular configuration whose base adjoins the stator and whose two opposite sides, defining said apex, are concave and continuously curved in transverse profile, the apex of the first spur being uniformly spaced from the main rotor along the whole length of that spur.

8. A machine as claimed in Claim 7 in which, when the trailing edge, considered in the direction of rotation of the main rotor, of the or each planetary rotor recess passing said first of the spurs is facing the apex of that spur, there is formed between the recess in that planetary rotor and the trailing side of that spur, considered in the direction of rotation of the main rotor, a combustion chamber which substantially wholly encloses the compressed fluid transferred across the spur during the movement of that planetary rotor past that spur.

9. A machine as claimed in Claim 8 further comprising a fuel injector and ignition device which are located in an end wall of said annular chamber for respectively supplying fuel to and igniting the resulting mixture in said combustion chamber.

10. A machine as claimed in Claim 9 in which an inlet port for supplying air to the annular chamber and an outlet port for removing exhaust gases from the annular chamber are located on either side respectively of a second one of said spurs.

11. A machine as claimed in Claim 10 in which there are only two spurs which are located diametrically opposite one another on the stator.

12. A machine as claimed in any of Claims 7 to 11 in which, when the or each planetary rotor passes said first spur, the trailing and leading side surfaces of that spur, considered in the direction of rotation of the main rotor, are respectively closely followed by the leading and trailing longitudinal edges of the or each planetary rotor recess, with the respective distance between said trailing side surface and said leading longitudinal edge, or edges, and between said leading side surface and said trailing longitudinal edge, or edges, remaining substantially constant during the whole of the pass.

13. A rotary piston machine constructed substantially as hereinbefore particularly described with reference to and as illustrated in Figs. 1 and 2 of the accompanying drawings.

14. A rotary piston machine constructed substantially as hereinbefore particularly described with reference to and as illustrated in Figs. 3 and 4 of the accompanying drawings.

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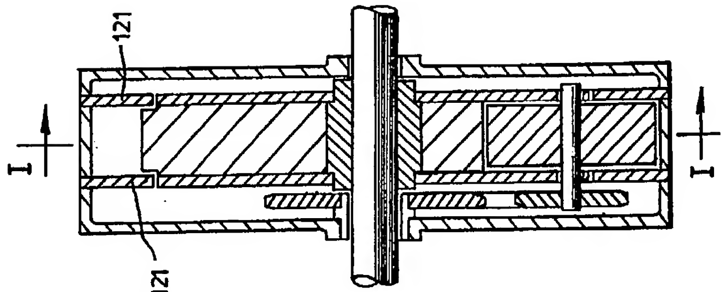
1362686 COMPLETE SPECIFICATION

2 SHEETS *This drawing is a reproduction of the Original on a reduced scale*

Sheet 1

FIG.2



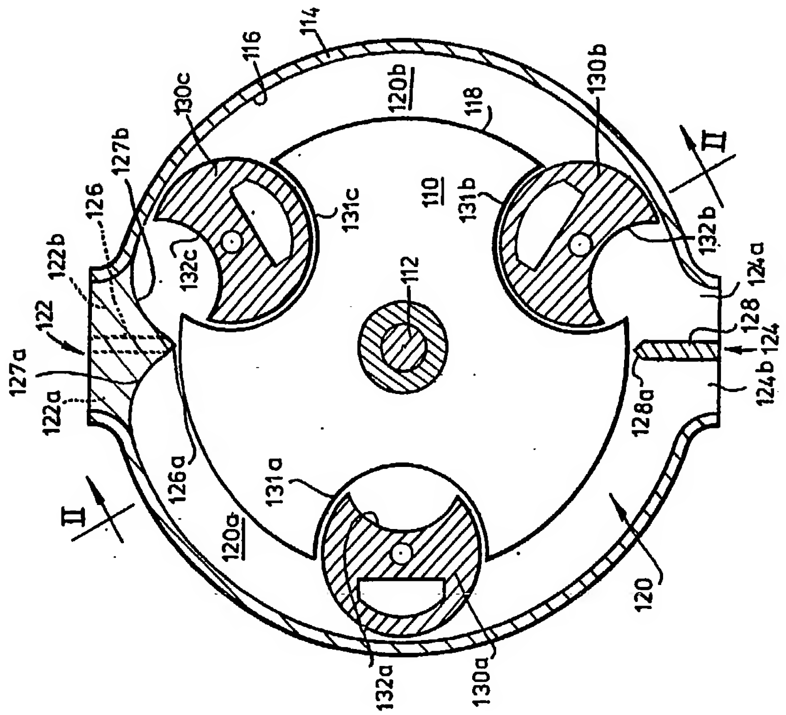




FIG.1

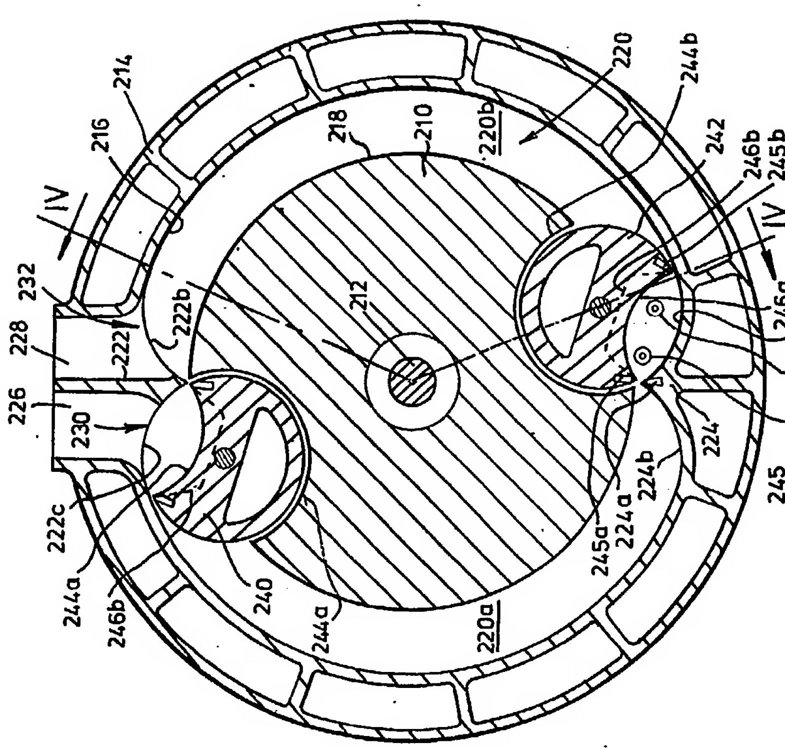



FIG 3

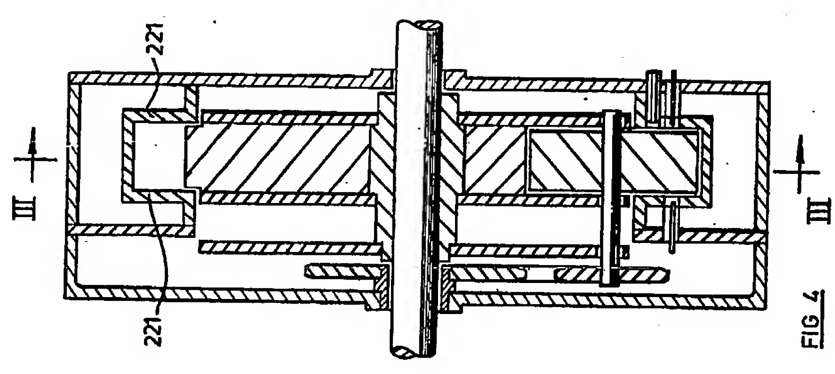



FIG 4

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DERWENT-ACC-NO: 1974-G4808V

DERWENT-WEEK: 197432

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TITLE: Rotary-piston pump, fluid motor, etc - has main rotor
carrying auxiliary rotors arranged in planetary fashion

PATENT-ASSIGNEE: CHESHIRE SOFTWARE[CHESN]

PRIORITY-DATA: 1971GB-0033861 (July 20, 1971)

PATENT-FAMILY:

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| GB 1362686 A | August 7, 1974 | N/A | 000 | N/A |

INT-CL (IPC): F01C001/26

ABSTRACTED-PUB-NO:

EQUIVALENT-ABSTRACTS:

TITLE-TERMS: ROTATING PISTON PUMP FLUID MOTOR MAIN ROTOR CARRY AUXILIARY ROTOR

ARRANGE PLANET FASHION

DERWENT-CLASS: Q51